Effect of local pollutant sources on aerosol-cloud interactions at Puijo measurement station

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Puijo measurement station has provided continuous data on aerosol-cloud interactions since summer 2006 (Leskinen *et al* 2009). The station is located on top of the Puijo observation tower (306 m a.s.l, 224 m above the surrounding lake level) near the town of Kuopio, Finland. The station is covered by cloud about 15 % of the time, offering perfect conditions for aerosol-cloud interaction studies. With a special inlet setup (total and interstitial inlets) activated and non-activated particles can be measured separately. Continuous twin-inlet measurements include aerosol size distribution (twin-DMPS, 7-800 nm), scattering and absorption. Other continuous measurements include cloud droplet number and size distribution and weather parameters.

We also arrange intensive measurement campaigns every autumn (Puijo Cloud Experiment, PuCE) when the occurrence of clouds is the highest. During these campaigns, extra measurement devices have included aerosol mass spectrometer (AMS), cloud condensation nuclei counter and Hygroscopic Tandem Differential Mobility Analyzer. The AMS has been connected to the twin-inlet system¸ providing data about the chemical composition of activated and non-activated particles (Hao *et al* 2013).

In our current work, we have been analyzing results from PuCE 2010 and 2011 campaigns. During these campaigns, a total of 39 cloud events took place, with a total of 156 hours of in-cloud data. The aim of the research has been the identification of the possible effect of local pollutant sources on aerosol-cloud interactions. The tower is surrounded by residential areas and traffic routes in north, east and south, whereas in west and northwest there aren't any significant sources. Also, two important point sources exist within a few kilometres from the tower, a paper mill and a heating plant.

An example of a cloud event, during which it was possible to pinpoint the effect of local sources, took place on 22.-23.10., 2011. There were several periods with different particle population properties, which also affected the cloud properties to some extent. Here, three of these periods are chosen for a closer inspection.

During the clean period (22.10. 22:00-23.10. 5:45), wind direction was from north and northwest with low total particle and accumulation mode concentrations (fig. 1a). Between 5:45-6:15 on 23.10. wind direction was from northeast where the paper mill is located. Total particle concentration was still low but a pronounced accumulation mode was present. Particle chemical composition during this period was dominated by SO_4 and NH_4. When wind direction shifted to south (23.10. 9:45-13:00), a plume from the heating plant hit the tower. Elevated particle concentration was observed, with a distinguishable accumulation mode, consisting almost entirely of SO_4.

During the pollutant episodes, the size of activated particles was larger when compared to the clean period (fig. 1b). In clean conditions, as small as 100 nm particles activated, whereas during the polluted periods the average diameter for activation was larger. During the paper mill plume, droplet concentration was higher (240 cm^{-3}) with a smaller average droplet diameter (10.9 µm) when compared to the clean period (138 cm^{-3}, 12.2 µm). Unfortunately the cloud droplet probe was frozen during the heating plant plume.

As a conclusion, it is evident that local pollutant sources affect aerosol-cloud interactions. However, it is too early to say if this is only caused by the elevated number concentrations or if the different chemical composition also plays a role. Also, how often these periods take place requires more research and data from forthcoming campaigns.

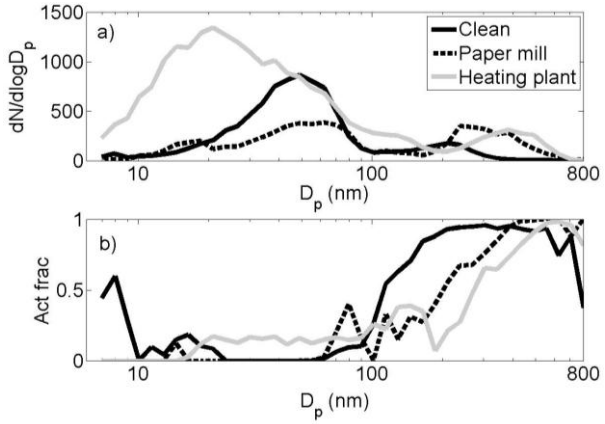

Figure 1. a) Total particle size distributions and b) particle activated fractions vs. size for the different periods during a cloud event on 22.-23.10.2011.

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